DOCUMENT RESUME

ED 200 230 IR 009 266

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TITLE A Review of the IEE's Involvement in Academic Gaming.
INSTITUTION Institution of Electrical Engineers, London (England).
PUB DATE Sep 79
NOTE 22p.

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Case Studies; *Educational Games; Electrical Occupations; *Engineering Education; Enrichment; Foreign Countries; Industrial Training; Postsecondary Education; Secondary Education; *Simulation
IDENTIFIERS *Institution of Electrical Engineers, United Kingdom

ABSTRACT

In partnership with the Institute of Technology in Aberdeen, the Institution of Electrical Engineers (IEE) has pioneered the development of a range of highly sophisticated simulation games and case studies based on realistic engineering scenarios for use in secondary and higher education and industrial training. The initial involvement of IEE in academic gaming through the "Power Station Game" Project is described, as well as the subsequent development of that project; the Broadcasting Game Project, in which IEE became involved in the actual development of games; and the recent expansion of publication activities with Peter Peregrinus Ltd. (PPL). A discussion of possible future developments concludes the main body of the report. More detailed information is provided in three appendices: the first describes six games published by IEE and PPL; the second lists 41 papers published on the games; and the third indicates conferences and seminars at which the games have been publicized. (CHC)

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A REVIEW OF THE IEE'S INVOLVEMENT IN ACADEMIC GAMING

by

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THE INSTITUTION OF ELECTRICAL ENGINEERS

A review of the IEE's involvement in academic gaming

by H I Ellington, E Addinall & M E Smythe

February 1979

1. Introduction

During the last four years, the IEE has become progressively more deeply involved in academic gaming. In partnership with Robert Gordon's Institute of Technology, Aberdeen, the Institution has pioneered the development of a completely new range of exercises, namely, highly-sophisticated simulation games and case studies based on realistic engineering scenarios. These have proved extremely successful both in secondary and tertiary education and in industrial training, and it is probably fair to say that the IEE is now the world leader in this field.

This report, which has been written for the information of IEE Members and Staff, reviews this area of the Institution's activities. It begins by explaining how the Institution first became involved in academic gaming through the "Power Station Game" Project and describing how this Project has subsequently developed. It then explains how the Institution became involved in the actual development of games through the Broadcasting Game Project. Next, the expansion of publication activities that has recently taken place, and the involvement of Peter Peregrinus Ltd., are described, and the main section of the report is then brought to a conclusion by indicating possible future developments.

For the benefit of those who require more detailed information about the Institution's involvement in academic gaming, three appendices are included in the report. The first gives further information about the various games that have been published by the IEE and PPL; the second lists the various papers that have been published on the games; the third lists the various conferences, seminars etc at which they have been publicised. Taken along with the main report, these appendices should provide the interested reader with a fairly comprehensive picture of the IEE's activities in the field of academic gaming.

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M E Smythe is the IEE's Director of Computer Services and a Director of Peter Peregrinus Ltd. He is also Chairman of the IEE Academic Games Committee.

2. The Power Station Game Project

In 1973, Professor N H Langton, Head of the School of Physics at Robert Gordon's Institute of Technology, was asked by the Scottish Central Committee on Physics to look into the possibility of developing a physics-based simulation exercise for use with senior pupils in Scottish secondary schools in the somewhat slack period after the end of the "Highers" examinations. The Scottish Central Committee on Physics subsequently set up an official Educational Games Sub-committee in Aberdeen, under the Chairmanship of Professor Langton, in order to carry out the work.

During the following two years, Professor Langton's Committee worked steadily on the development of an extended role-playing exercise simulating the various technical, economic, geographical and environmental decisions that have to be made when a new power station is being planned (see appendix A). The first draft of "The Power Station Game" was completed by June 1974, and, following a series of field trials in local schools, the game was completely re-written. A further series of field trials was held in June 1975, after which the game was again completely re-written in order to convert it into a suitable form for mass production. Following a number of unsuccessful approaches to commercial publishers, the Institution of Electrical Engineers agreed to publish the game, since they felt that it was not only an extremely useful educational exercise in its own right, but would also help to stimulate interest in engineering in schools (see paper 15 in Appendix B). The final package was prepared by H I Ellington (the editor of the game package) and M E Smythe (whom the IEE had placed in overall charge of their work on academic games), and "The Power Station Game" was eventually published early in 1976, after being refereed by M N John.

During the last three years, "The Power Station Game" has been supplied to over 200 schools, colleges, universities, education authorities, industrial organisations and government establishments in all parts of the world, and has been employed in a far wider range of roles than was ever envisaged by the team that developed it. Firstly, it has been extensively used in the role for which it was primarily designed, namely, as a "mind broadening" exercise for senior science pupils in secondary schools, and a large amount of highly-encouraging feedback has been received from teachers who have used the game in this way. Secondly, it has proved extremely successful as a case study for science and engineering students in colleges and universities (staff of the University of Utrecht actually went to the trouble of translating the game into Dutch so that it could be used with their students). Thirdly, the game has proved sufficiently realistic and sophisticated to enable it to be used as a training exercise for technical and managerial staff in a number of industries - including the power industry.

One totally unexpected application of "The Power Station Game" has been its use as the basis of an annual inter-school competition. In 1977, the Agecroft Training Centre of the Central Electricity Generating Board presented the IEE with a replica of a power station specially made by their apprentices - the Agecroft Trophy - to be completed for by teams playing "The Power Station Game". The first Agecroft Trophy Competition was held during the 1977 Conference of the Society for Academic Gaming and Simulation in Education and Training (SAGSET) in Aberdeen, when teams from three local schools competed for the trophy. In 1978, a similar competition was held in Brighton, again as part of the SAGSET Conference, and it is planned to run a third competition in Lancaster in 1979.

Because of the great success of "The Power Station Game", the IEE recently decided to produce a second edition, incorporating the various technical and economic changes that have taken place since the original game was published. (When the game was being developed, it was expected that the next generation of nuclear power stations would employ the Steam-Generating Heavy-Water Reactor system; the Government has since abandoned the SGHWR programme, however, and any new nuclear power station built during the next few years will now probably use the Advanced Gas-Cooled Reactor system. Also, costs have risen rather dramatically since the original game was published in 1975; at that time, the capital cost per installed kw of a new coal or oil station was of the order of £75, but this figure has now risen to roughly £300!). Work on the revision of the game (which was carried out by the three authors of this report) has now been completed, and the revised package should become available in the spring of 1979.
The IEE is also preparing a low-cost "conversion pack" that will be offered to everyone who has bought "The Power Station Game". By purchasing this pack, it will be possible to update the game package simply by removing those pages in the game booklets in which changes have proved necessary and replacing them with the revised versions. It is proposed to carry out further revisions of "The Power Station Game" as and when required, so that the exercise should never become outdated.

3. The Broadcasting Game Project

The great success of "The Power Station Game" following its publication at the beginning of 1976 encouraged the IEE to look for a possible successor. The idea for such a follow-up exercise came from Mr Smythe, who, in May 1976, asked Dr Ellington and Dr Addinall to prepare a discussion paper on the feasibility of developing a game based on broadcasting. As a result of the recommendations made in this paper, the IEE subsequently set up a Broadcasting Game Committee under the Chairmanship of Mr Smythe; this contained Dr Ellington, Dr Addinall and Mr M C Hately (a Senior Lecturer in the School of Electronic and Electrical Engineering) from RGIT, Mr J Fredericks of the IBA and Mr G Sturge of the BBC.

At the inaugural meeting of the above Committee (in January 1977), the IBA and BBC representatives offered to organise a series of visits to transmitting stations, broadcasting centres etc for the other members of the Committee so that they could gain the up-to-date background knowledge that they would need in order to work effectively on the project (only Mr Hately had any professional knowledge of broadcasting). This fact-finding tour (which the authors believe to be an essential preliminary to any project of this type) took place in April 1977, and, as a result, the three RGIT members of the Committee were able to identify the area of broadcasting which would be most suitable for use as the basis of the game (the provision of UHF television coverage to a remote, sparsely populated area) and formulate a possible structure for the exercise. They also decided to recommend that production and publication of the game package proper should be preceded by holding a national competition for schools based on the game scenario; this would serve the dual function of field testing the game documents and providing excellent publicity at school level for the various bodies associated with the project. Their various proposals, which were set out in a second discussion paper, were adopted by the Committee in June 1977.

During the following twelve months, the three RGIT members of the Committee first finalized the organisational details of the competition, which was to be known as "Project Scotia", and then developed the various competition documents. Production of the final competition package was proceeded by the development of two successive draft versions, each of which was amended as a result of feedback received from the BBC and IBA. The final documents were produced in June 1978, in time for the competition (which was to be run during the following winter) to be launched in the autumn as planned.

At the time of writing, the "Project Scotia" competition is still in progress. It is being played by invited schools from all parts of Britain, each of which has the task of designing a UHF television broadcasting network for the hypothetical Scotia Region (supposedly located somewhere on the West Coast of Scotland). Each school has to produce a written "consultants' report" on its proposed scheme and also prepare a multi-media presentation designed to show the scheme to best advantage. The "consultants' reports" will be assessed by the project authors in April, after which each school in the competition will be visited by a member of the Broadcasting Game Committee so that the multi-media presentations can be assessed. The best three schools will then be invited to take part in a live final, to be held at Savoy Place on Thursday 13 September 1979.

Once the "Project Scotia" competition has ended, it is planned to develop a self-contained teaching package based on the competition scenario. It is expected that this will take the form of a multi-project pack of the type described in Sections 4 and 5 below and in Appendix A (see sections on "Hydropower" and "Central Heating Game").

4. Other games published by the IEE

During the last three years, the North of Scotland Hydroelectric Board has organised two major competitions for secondary schools in its area. The first, "Hydropower 77", was run during the winter of 1976-77 and involved designing a 1000 MW hydroelectric pumped storage scheme (see papers nos. 7 and 23 in Appendix B). The second, "Power for Elaskay", was run during the following winter and involved devising a programme for meeting the future electricity needs of a hypothetical offshore island (see paper no. 16 in Appendix B). The projects used as the basis of the two competitions were developed by Dr Ellington and Dr Addinall in collaboration with Mr I H Smith, the NSHEB's Press and Public Relations Officer, and both have subsequently been converted into self-contained teaching packages and published by the IEE.

The "Hydropower 77" project was converted into the "Hydropower" multi-project pack - at that time, a completely new type of learning package. In this type of package, the same basic scenario and set of resource materials are exploited in a variety of different projects designed for use in the teaching of different academic subjects (see Appendix A and papers nos 10 and 12 in Appendix B for details). Hydropower was published in the Autumn of 1977, and has since been purchased by over 100 schools, Universities, training establishments etc, in all parts of the world. Feedback received from these various bodies has been extremely encouraging, and indicates that "Hydropower" has been just as successful as "The Power Station Game".

The Project used in the second NSHEB competition was also converted into a completely new type of learning package - a structured lesson built round a simulated case study (see Appendix A and papers nos. 24 and 28 in Appendix B for details). This was published under the name "Power for Elaskay" in the autumn of 1978, and is already proving to be extremely successful in a variety of roles. It has, for example, been built into the curriculum of the "Science in Society" course currently being developed by the Association for Science Education (see Section 6 below), and, somewhat to the surprise of the Authors, seems likely to find extensive usage as a language training exercise (this possible application emerged when Dr Ellington recently demonstrated "Power for Elaskay" at a conference in Paris - see no. 19 in Appendix C).

5. Games published by Peter Peregrinus Ltd

While developing the various games described above, Dr Ellington and his colleagues at RGIT were also working on a number of other projects, which, although not directly related to electrical engineering, all had science themes. The IEE (because of the limitations imposed by its Charter) was not able to publish these exercises. An approach was made to Mr Smythe in his capacity as a Director of Peter Peregrinus Ltd, and, as a result, PPL undertook to publish the three RGIT games that were currently available, namely, the "Central Heating Game", "Fluoridation?" and "Point Fields".

The "Central Heating Game" is a multi-disiplinary multi-project pack, similar in format to "Hydropower", on the theme of domestic central heating and insulation (see Appendix A and paper no. 19 in Appendix B for details). The package was published in the autumn of 1978, ready for use in the 1978-79 field trials of the ASE's, "Science in Society" course for which it had been designed. Feedback received to date indicates that the package is having the intended impact.

"Fluoridation?" is a role-playing exercise simulating a public meeting held to discuss the question of whether or not fluoride should be added to the public water supply. It will be published in the spring of 1979. The exercise has been thoroughly field tested by a number of educational and medical bodies, and has already aroused considerable interest.

"Point Fields" is another role-playing exercise, this time simulating a public inquiry into the siting of a large petrochemical plant. It is also due to be published in the spring of 1979, and, like "Fluoridation?" has already aroused a considerable amount of interest in educational circles.

6. Possible future developments

During the last five years, all the people who have been involved in the development of "The Power Station Game" and the other science-based games described above have become convinced that exercises of this type are capable of making an extremely valuable contribution to the education of our future citizens (see papers nos. 5, 11, 14, 15, 21, 25, 27, 30 and 31 in Appendix B). They can, for example help to bridge the "two culture" gap by (a) providing students of science and technology with a much broader, more liberal education than can possibly be provided by traditional teaching methods, and (b),when incorporated into non-science

courses as "associated studies", demonstrating the vital role played by science and technology in modern society. They also incorporate many of the features most highly valued in current educational thinking (high student involvement, active decision making, group interaction, peer teaching etc). Thus by making exercises such as "The Power Station Game" and "Power for Elaskay" generally available to the educational community, the IEE is not only helping to promote engineering in general and electrical engineering in particular, but is also making a very significant contribution to the development of our educational system. The value of this contribution is now achieving widespread recognition at all levels up to and including the Minister of Education, Mrs. Shirley Williams.

This recognition is illustrated by the fact that the Association for Science Education has completely re-designed some of the most important sections of its new "Science in Society" course in order to incorporate academic games published by the IEE and PPL and other exercises of a similar nature designed specifically for use in the course. (One such exercise is "The BuenaFortuna Power Project", an abridged version of "The Power Station Game" developed by Dr Ellington and Dr Addinall at the request of Mr John Lewis, Chairman of the "Science in Society" Project Team. Copyright easement has been granted to the ASE by the IEE in order to allow them to publish the exercise as part of the course package). All three authors of this report were also invited to join the "Science in Society" Project Team in 1977, and have since been actively involved in the development of the course.

The introduction of games and simulations into the ASE's "Science in Society" course represents an extremely important development in the use of such exercises. Previously, games and simulations were, in general, only used as "optional extras" by a few enthusiastic teachers and lecturers; now, however, they are being built into the fabric of a major national course as an integral part of its curriculum. The authors are convinced that games and simulations will play an increasingly important part in the planning of future science courses in our schools, colleges and universities, and are confident that the various games being published by the IEE and PPL will be used in many of these courses.

One result of the rapid expansion of the IEE's involvement in academic gaming that has taken place over the last year is that the Institution recently decided to transfer responsibility for academic games from its Computer Services Department at Hitchin to the Schools Liaison Section of its Qualifications Department at Savoy Place. Another result is that the Institution has set up an Academic Games Committee in order to monitor its activities in the field and make recommendations for future developments. This is chaired by Mr Smythe, and comprises representatives of RGIT (Drs Addinall and Ellington) and appropriate members of the staff of the IEE. The Committee reports direct to Dr Laverick.

One highly - ambitious long-term project currently being planned by the above committee is the development and publication of a series of eight modular teaching packages based on the theme of "Our Technological Society." All eight modules will be built round specially-developed games, simulations and case studies, and will be primarily designed for use with middle ability pupils in the 3rd and 4th forms of secondary schools - a sector of the school population for which virtually no provision has been made in the development of academic games.

APPENDIX A

Information about various games published by IEE & PPL

1. The Power Station Game

Nature of exercise: A manual role-playing case study simulation-game concerned with the choice of type and siting of a new 2000 MW power station, the object being to reach a decision as to which type of station to build and where to site it. The participants are divided into three teams, each of which has to prepare and present a case for building one particular type of station. The winning team has then to defend its scheme at a simulated public inquiry.

Target population: Primarily designed for use at upper secondary and tertiary level, but can also be used in industrial and managerial training.
No. of participants required: 12-24 (optimum no. 18)
Minimum time required: 2 days (10 hours)
Contents of package: Teacher's Guide plus all resource material needed for use with 18 participants.
Authors: H I Ellington (game editor), T Carnie A G Garrow J Graham K Jackson N H Langton H McLaven & J R Muckersie.
Publisher: IEE (Available from Publication Sales Department IEE Station House, Nightingale Road, Hitchin, Herts.
Price: £25.00 (inc. VAT and p & p).

2. Hydropower

Nature of exercise: A multi-disciplinary multi-project pack - a new type of manual educational package that exploits the same set of resource materials in a series of projects designed for use in the teaching of a wide range of academic subjects (geography, modern studies, economics, physics and engineering). It is based on a scenario that involves finding the best site for a 1000 MW hydroelectric pumped storage scheme in a hypothetical area near the W coast of Scotland and carrying out a detailed design study on each of the possible schemes. The package includes six basic projects.
Target population: Primarily designed for use at upper secondary and tertiary level, but can also be used in industrial and managerial training.
No. of participants required: Each project is designed for use with a class of up to 24, but all projects can also be used with much smaller numbers.
Minimum time required: The projects vary in length from 1-3 hours.
Contents of package: Teacher's Guide plus all resource material needed for use by up to 24 participants.
Authors: H I Ellington and E Addinall.
Publisher: IEE (Publication Sales Dept., IEE Station House, Nightingale Road, Hitchin, Herts).
Price: £12.00 (inc. VAT and P & P).

3. Power for Elaskay

Nature of exercise: A manual case study simulation concerned with the exploitation of alternative energy resources. It is based on the hypothesis that the (imaginary) offshore island of Elaskay wishes meet its future electricity requirements by making use of its natural energy resources (peat, solar energy, wind energy, tidal energy hydroelectric power). The technical and economic feasibility of exploiting each of these resources is first examined by five working

A draft version of the first module (on "Energy Resources") has now been completed, and is about to undergo field trials in secondary schools in various parts of Britain; it will be followed by modules on "Raw Materials", "Industry", "Transport", "Communications", "Defence", "Food" and "Health". The "Our Technological Society" project is currently causing considerable interest in educational circles, and it is hoped that the series will eventually be adopted as the basis of a nationally-recognised course.

groups, and the groups then pool their results and devise a rolling programme for meeting Elaskay's electricity needs over the next 50 years.
Target population: Primarily designed for use at upper secondary and tertiary level.
No. of participants required: Minimum 5; maximum 25.
Minimum time required: 3 hours (5 school periods).
Contents of package: Teacher's Guide plus all resource material needed for use with up to 25 participants.
Authors: H I Ellington & E Addinall.
Publisher: IEE (Publication Sales Department IEE Station House Hitchin, Herts).
Price: £7.00 (Inc. VAT and P & P).

4. Central Heating Game

Nature of exercise: A manual multi-disciplinary multi-project pack in similar format to "Hydropower". It deals with the technical and economic aspects of domestic central heating and insulation, and contains five basic projects, designed for use in the teaching of a wide range of academic subjects (architecture, economics, engineering, home economics, general studies, physics and science in society). The scenario for the various projects is based on a typical three-bedroomed bungalow.
Target population: Primarily designed for use at upper secondary and tertiary level.
No. of participants required: Each project is designed for use with a class of up to 24, but all projects can also be used with much smaller numbers.
Minimum time required: The projects vary in length from 1-2 hours
Contents of package: Teacher's Guide plus all resource material needed for use with up to 24 participants.
Authors: A Cowking, H I Ellington, E Addinall and N H Langton.
Publisher: Peter Peregrinus Ltd (available from Publication Sales Dept, Station House, Hitchin, Herts).
Price: £9.00 (Inc. VAT and P & P).

5. Fluoridation?

Nature of exercise: A manual role-playing case study simulation-game that takes the form of a simulated public meeting held by local Health Council to discuss the question of whether to introduce fluoride into the public water supply. The case for fluoridation is presented by the Chief Administrative Dental and Medical Officers, and evidence is then given by various bodies and individuals who support or oppose fluoridation. The Local Health Council then decide whether or not to implement a programme of fluoridation.
Target population: Primarily designed for use at upper secondary and tertiary level.
No. of participants required: 13-24 (optimum no. 18).
Minimum time required: 1½-2 hours.
Contents of package: Teacher's guide plus all resource material needed for use with up to 24 participants.
Authors: F Percival & H I Ellington.
Publisher: Peter Peregrinus Ltd (Available from Publication Sales Dept IEE Station House, Hitchin, Herts from June 1979).
Price: £10.00 (Inc. VAT and P & P).

6. Point Fields

Nature of exercise: A manual role-playing case study simulation-game that takes the form of a simulated public inquiry into the siting of a large petrochemical complex. Evidence is presented by the proposers of the scheme and by various supporters and objectors, and and a Reporter then decides whether or not the project should go ahead.
Target population: Primarily designed for use at upper secondary and tertiary level, but can also be used in industrial and managerial training.
No of participants required: Minimum 12 maximum 30.
Minimum time required: 1½-2 hours
Contents of package: Teachers' Guide plus all resource material needed for use with up to 30 participants.
Authors: H I Ellington, A G Garrow & J R Muckersie.
Publisher: Peter Peregrinus Ltd (Available from Publication Sales Dept., IEE Station House, Hitchin, Herts from June 1979).
Price: £10.00 (Inc. VAT and P & P).

APPENDIX B

List of papers published on IEE and PPL games

1. "The Power Station Game", by H I Ellington and N H Langton; SAGSET Journal; Vol 5; no. 1; pp 31-35 (1975).

2. "The Power Station Game - a new physics-based simulation game for use in schools", by H I Ellington & N H Langton; Bull. of Scot Centre for Maths, Science & Tech Ed; no. 5; pp 26-30 (1975).

3. "The Power Station Game", by H I Ellington and N H Langton; Physics Education; Vol 10; no. 6; pp 445-447.

4. "The physics of power stations. Part 1, fossil-fuelled power stations", by N H Langton and H I Ellington; Physics Education; September 1975; pp 448-452.

5. "The physics of power stations. Part 2 nuclear power stations", by H I Ellington and N H Langton; Physics Education; November 1975; pp 504-508.

6. "The Power Station Game - a new educational game for use in schools", by H I Ellington; School Science Review; vol 58; no. 202; p 150 (1976).

7. "Hydropower 77", by H I Ellington and E Addinall; Bull. of Scot.Centre for Maths, Science and Tech; Ed; no. 9; pp 9-10 (1976).

8. "Point Fields Public Enquiry", by H I Ellington, A G Garrow and J F Muckersie; Bull. of Scot. Centre for Maths Science and Tech. Ed.; no. 11; pp 23-26 (1977).

9. "Educating 'through' science using multi-disiplinary simulation games", by H I Ellington and F Percival; Programmed Learning and Educational Technology; vol 14; no. 2; pp 117-126 (1977).

10. 'The Multi-Disciplinary Multi-Project Pack - a new concept in simulation gaming", by H I Ellington and E Addinall; Programmed Learning and Educational Technology; vol 14; no. 3; pp 213-22 (1977).

11. "Science-based simulation games - a means of bridging the 'two culture' gap", by H I Ellington and F Percival; Proc of VIIIth ISAGA Conference (University of Birmingham 1977); Section 1, no 1.

12. "The Pumped-Storage Multi-Project Pack - a new type of simulation exercise", by H I Ellington and E Addinall; Proc. of VIIIth ISAGA Conference (University of Birmingham 1977); Section 3; no 1.

13. "Fluoridation? - a new role-playing game for use in schools and colleges", by F Percival and H I Ellington; Proc. of VIIIth ISAGA Conference (University of Birmingham 1977).

14. "The place of multi-disiplinary games in school science", by H I Ellington and F Percival; School Science Review; vol 59; no 206; pp 29-35 (1977).

15. "Educational games - a means of promoting electrical engineering", by H I Ellington, N H Langton and M E Smythe; IEE News; September 1977; no 21 (new series); pp 10-11.

16. 'Power for Elaskay', the Hydroboard's new competion for secondary schools", by H I Ellington, E Addinall and I H Smith; Bull. of Scot.Centre for Maths, Science and Tech. Ed; no 12; pp 21-23 (1977).

17. "The use of simulation-games in schools - a case study", by H I Ellington, N H Langton and M E Smythe. In "Aspects of Educational Technology" (P Hills and J Gilbert, eds.) - Kogan page 1977; pp 399-406.

18. "The Power Station Game Competition for the Agecroft Trophy", by H I Ellington, N H Langton and M E Smythe; SAGSET Journal; Vol 1; no 2; pp 56-63 (1978).

19. "The Central Heating Multi-Project Pack", by A Cowking, H I Ellington and N H Langton; Physics Education; vol 13; pp 214-216 (1978).

20. "The physics of central heating of houses", by A Cowking, H I Ellington and N H Langton; Physics Education; vol 13; pp 217-223 (1978).

21. "The applications of multi-disciplinary educational games in schools", by H I Ellington and N H Langton. In "Perspectives on Academic Gaming and Simulation 1 and 2" (J Megarry ed.) - Kogan page 1978; pp 76-79.

22. "A simulated public inquiry for use in schools and colleges", by H I Elli... A G Garrow and J R Muckersie. In "Perspectives on Academic Gaming and Simulation 1 and 2" (J Megarry ed) - Koga... Page 1978; pp 85-91.

23. "Hydropower 77", by E Addinall and H I Ellington. In "Perspectives on Academic Gaming and Simulation 3" (R McAleese ed) - Kogan Page 1978; pp 144-148.

24. "Power for Elaskay - a learning package on alternative energy resources for use by science teachers", by H I Ellington and E Addinall; School Science Review; June 1978; pp 747-750.

25. 'Science-based simulation games for the high school"; by H I Ellington, E Addinall, N H Langton, F Percival, I H Smith and M E Smythe; Proc. of 16th NASAGA Conference (North American Simulation and Gaming Association, 1978); pp 152-155.

26. "The Power Station Game family of technological/environmental simulations", by H I Ellington, E Addinall, N H Langton, F Percival and M E Smythe; Proc. of 16th NASAGA Conference (North American Simulation and Gaming Association 1978); pp 156-160.

27. "Teaching tomorrow's citizens about energy: the potential role of simulation games", by M E Smythe, H I Ellington and E Addinall; Proc. of 1Xth ISAGA Conference (University of Lund, Sweden - 1978).

28. "Power for Elaskay - a case study on alternative energy resources", by H I Ellington, E Addinall and M E Smythe; Proc. of 1Xth ISAGA Conference (University of Lund, Sweden - 1978).

29. "Fluoridation? - a role-playing simulation game for schools and colleges", by F Percival and H I Ellington; SAGSET Journal; vol 8; no 3; pp 93-99(1978).

30. "Using simulations and case studies to teach the social relevance of science", by H I Ellington, E Addinall, F Percival and M E Smythe. In E Boeker, (ed); "Science, Society and Education" (Free University, Amsterdam), pp 189-193 (1978)

31. "Science policy games", by M Berry; review published in "New Scientist", December 14 1978, pp 865-866.

31. "Building science-based educational games into the curriculum", by H I Ellington, F Percival and E Addinall. In D Brook and and W P Race (eds), "Aspects of Educational Technology XII" (Kogan Page); pp 263-268 .

32. "Using simulations in the ASE's 'Science in Society Project'"by H I Ellington E Addinall, F Percival and J L Lewis. In J Megarry (ed), "Perspectives on Academic Gaming and Simulation 4" (Kogan Page) pp 79-88.

33. "An attempt to evaluate "Fluoridation?", - a role-playing simulation exercise" by F Percival and H I Ellington. In J Megarry (ed), "Perspectives on Academic Gaming and Simulation 4" (Kogan Page); pp 55-66.

34. "The 1978 Agecroft Trophy Competition" by M E Smythe, V A Mellor and H I Ellington. In J Megarry (ed) "Perspectives on Academic Gaming and Simulation" (Kogan Page); pp 95-98.

35. "Building case study simulations into the curriculum as part of structured lessons", by H I Ellington and E Addinall. SAGSET Journal; Vol 19; no 1; pp 13-19.

36. "The 'Power Station Game' Project and its aftermath" by H I Ellington and N H Langton; bull. of Scottish Centre for Maths, Science and Tech. Ed., no 15; pp 11-18.

37. "Simulated case studies - new training tools for the power industry", by H I Ellington, E Addinall and N H Langton. Petroleum News (in press).

38. "Simulation-games and case studies - some relationships between objectives and structure", by H I Ellington, F Percival and E Addinall. Paper in preparation for 1979 APLET Conference, Sheffield (abstract accepted by Papers Committee).

39. "Designing science-based simulation/games - a systems approach", by E Addinall, H I Ellington and M E Smythe. Invited paper in preparation for 1979 ISAGA Conference, Holland.

40. "Using simulation/gaming techniques to teach the social relevance of physics", by H I Ellington, E Addinall, N H Langton and M E Smythe. Invited paper in preparation for international GIREP Conference on Physics Teaching to be held in Israel in August 1979.

41. "Fluoridation?", by F Percival and H I Ellington. Invited paper in preparation for British Dental Journal.

APPENDIX C

List of conferences, seminars etc at which IEE and PPL games have been or are to be publicised

1. September 1974, Fifth Annual Conference of SAGSET (Society for Academic Gaming and Simulation in Education and Training), Loughborough University of Technology. Paper presented by H I Ellington (no. 1 in appendix B).

2. April 1976, ETIC 76: Tenth Annual Conference of APLET (Association for Programmed Learning and Educational Technology), Dundee College of Education." The Power Station Game" displayed (by H I Ellington) in Members' Exhibition.

3. September 1976, Seventh Annual Conference of SAGSET Loughborough University of Technology. Paper presented by H I Ellington (no. 21 in Appendix B) and participation session of "Point Fields" run (see paper no. 22 in Appendix B).

4. March 1977, Eighth Annual Convention of Institution of Electronics, Edinburgh University. Three talks on academic gaming given by H I Ellington.

5. March 1977, ETIC 77: Eleventh Annual Conference of APLET, University of Surrey. Paper presented by H I Ellington (no. 17 in Appendix B). IEE games displayed in Members Exhibition.

6. April 1977, Colloquium on Educational Games at IBA Headquarters, Crawley Court, Winchester. Talk given by H I Ellington.

7. July 1977, Eighth Annual Conference of ISAGA (International Simulation and Gaming Association), University of Birmingham. Two papers presented by H I Ellington (nos. 11 and 12 in Appendix B) and participation session of "Fluoridation?" run (see paper no 13 in Appendix B). IEE games displayed in Members' Exhibition.

8. September 1977, Eighth Annual Conference of SAGSET, Robert Gordon's Institute of Technology, Aberdeen. Paper presented by E Addinall (no. 23 in Appendix B) and participation session of "Fluoridation?" run. First competition for Agecroft Trophy held (see paper no. 18 in Appendix B). IEE games displayed in Members' Exhibition.

9. October 1977, Sixteenth Annual Conference of NASAGA (North American Simulation and Gaming Association), Boston, Mass, USA. Two papers presented by H I Ellington (nos. 25 and 26 in Appendix B) and participation session of one of "Hydropower" projects run by H I Ellington and M E Smythe. IEE games displayed in Members' Exhibition.

10. March 1978, Joint IEE/IMechE School Liaison Officers Conference Birmingham. Talk on academic gaming given by H I Ellington.

11. April 1978, ETIC 78: Twelfth Annual Conference of APLET, Polytechnic of Wales, Pontypridd. Paper presented by H I Ellington (no. 31 in Appendix B) and participation session of "Point Fields" run. IEE games displayed in Members' Exhibition.

12. July 1978, International Exhibition of Games and Simulations, Royal College of Art, London. "Power Station Game" exhibited.

13. July 1978, Ninth Annual Conference of ISAGA, University of Lund, Sweden. Paper presented by M E Smythe (no. 27 in Appendix B) and participation session of "Power for Elaskay" run (see paper no. 28 in Appendix B). IEE games displayed in Members' Exhibition.

14. August 1978, International Conference on "Science, Society and Education" Free University of Amsterdam, Holland. Paper presented by H I Ellington (no. 30 in Appendix B). IEE games displayed in Exhibition.

15. September 1978, Seminar for members of Association for Science Education's "Science in Society" Project Team. Talk on academic games given by H I Ellington and participation sessions of "Power for Elaskay" run by H I Ellington and E Addinall.

16. September 1978, Ninth Annual Conference of SAGSET, Brighton Polytechnic Papers presented by H I Ellington (no. 32 in Appendix B) and F Percival (no. 33 in Appendix B). Participation session of "Power for Elaskay" run by E Addinall. Second competition for Agecroft Trophy held (see paper no. 34 in appendix B). IEE and PPL games displayed in Members' Exhibition.

17. November 1978, Seminar on academic gaming held in Brighton Polytechnic by H I Ellington and E Addinall. "Power for Elaskay" run as participation session.

18. December 1978, British Association Young Scientists Christmas Lecture on academic gaming given by H I Ellington in Southampton University.

19. January 1979, Conference on academic gaming organised by British Council and SAGSET in Paris. Participation session of "Power for Elaskay" run by H I Ellington.

20. March 1979, Seminar for local teachers to be organised in Southampton University by Southern Science and Technology Forum. H I Ellington and E Addinall to talk on IEE games and run participation sessions.

21. March 1979, Joint IEE/IMechE School Liaison Officers' Conference, Loughborough. Participation sessions of "Power for Elaskay" run by H I Ellington, E Addinall and M E Smythe. Power Station Game to be played by a local School.

22. March 1979, Institute of Physics, Education Group Conference, Cambridge. Participation session of Power for Elaskay to be run by H I Ellington, E Addinall and M E Smythe.

23. April 1979, ETIC 79: Thirteenth Annual Conference of APLET to be held in Sheffield City Polytechnic. Paper to be presented by H I Ellington (see no. 38 in Appendix B) and participation session of "Power for Elaskay" to be run by E Addinall. IEE and PPL games to be displayed in Members' Exhibition.

24. May 1979, Institute of Physics Conference on "Educating Through Physics", to be held in Stirling University. Invited talk on academic games to be given by H I Ellington.

25. July 1979 Tenth Annual Conference of ISAGA to be held in Amsterdam Holland. Invited paper to be presented by E Addinall (see no. 39 in Appendix B). IEE and PPL games to be displayed in Members' Exhibition.

26. August 1979, International Conference on Physics Teaching to be held in Weizmann Institute, Israel. Invited paper to be presented by H I Ellington (see no. 40 in Appendix B). Participation session(s) to be run. IEE and PPL games to be displayed in Exhibition.

27. September 1979, Tenth Annual Conference of SAGSET to be held in Polytechnic of Wales. Paper to be presented by H I Ellington and participation session to be run. IEE and PPL games to be displayed in Members' Exhibition.

28. September 1979, Live Final of "Project Scotia" Competition to be held at Savoy Place.